

PROGRESS REPORT ON NASA RESEARCH GRANT NGR-05-035-003 FOR THE PERIOD 1 OCTOBER 1965 THROUGH 30 SEPTEMBER 1966. "STUDY OF BODY ENERGY CONSERVATION, EMPHASIZING SPACE FLIGHT ENVIRONMENTAL EFFECTS ON ORGANISMS"

During the period of this grant (1 year) personnel have been acquired and trained in the chemical and enzymological techniques required in conducting the research outlined in the proposal. Essentially all equipment are now available as are facilities except for a cold room. At present, refrigerators are being used until a cold room can be obtained.

During the initial phases of the research, the response of adipose tissue to various hormones have been tested for release of free fatty acids and uptake of glucose. Both the isolated fat cells and intact epididymal fat pads have been used as test material. It has been shown for the normal rat that adipose tissue cells and fat pads release free fatty acids (FFA) and take up glucose well under the stimulus of epinephrine when incubated in vitro at 37°C. When the incubation temperature is lowered to 15°C FFA release in response to epinephrine is drastically reduced and glucose uptake is essentially stopped. When incubated at 5° both FFA release and glucose uptake has ceased.

Rats were cooled until their deep body reached 5°C, a body temperature commonly reached by hibernating animals. Fat pads from these rats did not release FFA when incubated at 15° and the release was markedly less at 37° as compared with rats not previously cooled.

Fat pads from normal rats responded to insulin in the incubation medium by a decrease in FFA release and a pronounced uptake of glucose. When incubated at 15°C the insulin responses were essentially abolished.

Thus it may be concluded that a nonhibernating animal (rat) can release FFA needed for energy at temperatures of 15°C but not at temperatures well tolerated by hibernating mammals.

For hibernating animals, arrangements had been made to use bats which are available in this area, but it proved more convenient to use the golden mantled ground squirrel at this time. In all probability bats will be used later to supplement the findings on ground squirrels.

Work on the ground squirrels has been underway for only a short time, but it is evident that they respond to low temperatures in a manner different from the rat. That is, epinephrine-release of FFA from adipose tissue continues, although at a lower rate, even when incubated at 5°C. It is somewhat difficult to make comparisons of absolute FFA release rates between rat and ground squirrel because of the structural differences in the fat pads. Ground squirrel fat pads are much thicker and consequently the penetration of hormones and FFA release may be retarded.

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Sufficient ground squirrels are now on hand to enable studies to be carried out as the animals reach hibernation, during hibernation and during arousal. In addition to the responses noted above, measurements are also being made of the following enzymes in liver and adipose tissue: glutamic oxaloacetic transaminase, glutamic pyruvic transaminase, NADP-malic dehydrogenase, glucose-6-phosphate dehydrogenase, alpha glycerophosphate dehydrogenase and citrate cleavage enzyme. Preliminary results on animals preparing for hibernation indicate that enzyme activities are much lower than values obtained on rat tissue. The significance of these results are not clear as yet, but similar measurements will be made on the ground squirrel as it is in hibernation at 5° and during arousal in order to better understand the intermediary metabolism of that animal. Additional enzymes to test the operation of the Krebs cycle (e.g., isocitric dehydrogenase) as well as NAD-malic dehydrogenase and hexokinase will be measured.

Seven different tissues have been and will be taken for later studies on the lipid classes by thin layer chromatography and for fatty acid composition by gas liquid chromatography. The enzyme studies cited above will soon be supplemented by studies on intermediary metabolism in liver and adipose tissue using radioactive substrates.

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